Design, Measurement, and Procedure for Assembling SMA-96 Mil 2.33 Dielectric Constant Stripline Topologies

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Abstract: *Many of the microwave boards that are used in the Antiproton Source stochastic cooling systems use a stripline topology for design criteria. The connection from a coaxial cable to the stripline was designed and the procedure to make this transition is outlined. Measurements indicating the performance of this transition are presented.*

I. Introduction

Microwave connections are difficult and the design from one topology to another is often critical for a design to function as required. Many of the designs used in the Debuncher stochastic cooling system use a three layer stripline topology. The design of a successful stripline launch was therefore crucial for the boards to function properly.

The stock material that was used was 45 mils thick, has a dielectric constant of 2.33, loss tangent of 0.002, and is specifically the Arlon LX-04503355 material. Two of these layers are pressed together with a thin bonding layer in between to produce a board that is a total of 96 mils thick. The design of the microwave launch into this topology was simulated and optimized for a broadband match. The measurement results will be

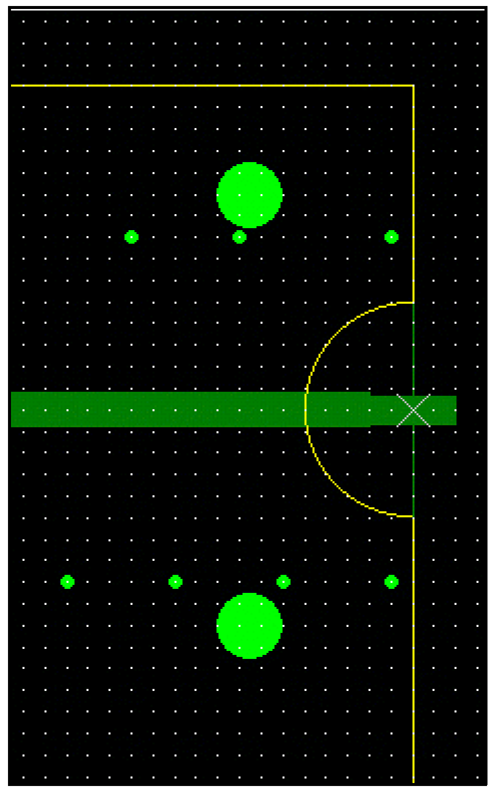

Figure 1. The strip layer, or layer in dark green, has a line thickness of 76 mils to achieve a 50S line impedance. At the edge of the board, the line thickness is decreased to 66 mils to accommodate the additional conductor height added by the tab of the connector. The connector used is the MA/COM 2052-1618-02. No differences were observed between the gold connector and the stainless steel connector

presented, and specifics of the design are presented.

II. Mechanical Designs

The interface between the SMA connector and stripline is described easily with the picture shown in Fig. 1.

Figure 2. A close-up picture of an actual connector interface. Some of the adhesive material is seen in this photo. The adhesive material oozes out of the board while the board is being heated and pressed together. The adhesive material has the same dielectric constant as the bulk of the board and does not deleteriously affect the microwave launch. The transition from 76 mils to 66 mils is easily seen.

An actual photo of the board is shown in Fig. 2. One can see that the line has a disruption at the edge of the board. This disruption accommodates the additional metal height of the tab of the connector as well as the solder. The strip width is 76 mils, while the disrupted width is 66 mils.

In the photo of Fig. 2, there is some blur or "goo" caused from the glue that is used to hold the top layer to the bottom layer. While the boards are being pressed together, the boards are heated slightly and this causes the glue to come out from the interface between the two boards. This excess glue is wiped away using a soldering iron to heat up the excess glue and slightly melt it and small piece of solder wick which soak up the melted glue, or allows the melted glue to adhere to the copper on the solder wick.

A picture of the parts necessary to complete a launch are shown in Fig. 3. The semicircular cutout piece is etched clean on the bottom and fills the void. The connector is soldered to the strip. Not pictured on this is the hardware which holds the connector firmly to the circuit card. This hardware can be found in FNAL drawing numbers 8035-MB-375835 and 8035-MB-375836.

Note that on Fig. 3, the small 25 mil holes on either side of the trace are used to stitch the top ground plane to the bottom ground plane. These holes are chosen to be at least 3 board heights away from the trace. This means that the via holes are placed at least 300 mils away from the trace edges. The boards that I designed I placed the via holes always centered at least 350 mils away from the trace edges.

A picture of the connector

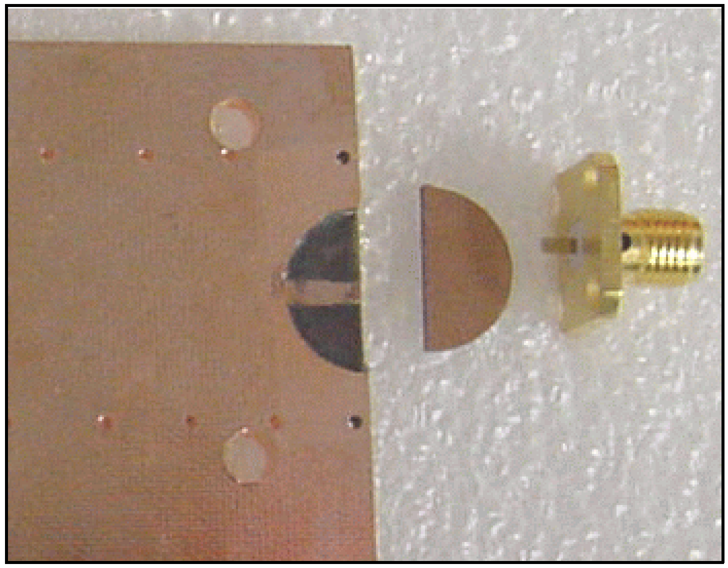

Figure 3. The circuit board is on the left. A small semicircular cutout is manufactured and is placed in the void. The bottom of the semicircular cutout is etched clean of all copper. Not pictured in this figure are the two pieces of hardware which hold the connector firmly in place. The two 140 mil holes, depicted to the left of the cutout section on the circuit board, are used for this hardware. The small holes on the circuit board are via holes which stitch the top and bottom ground planes together.

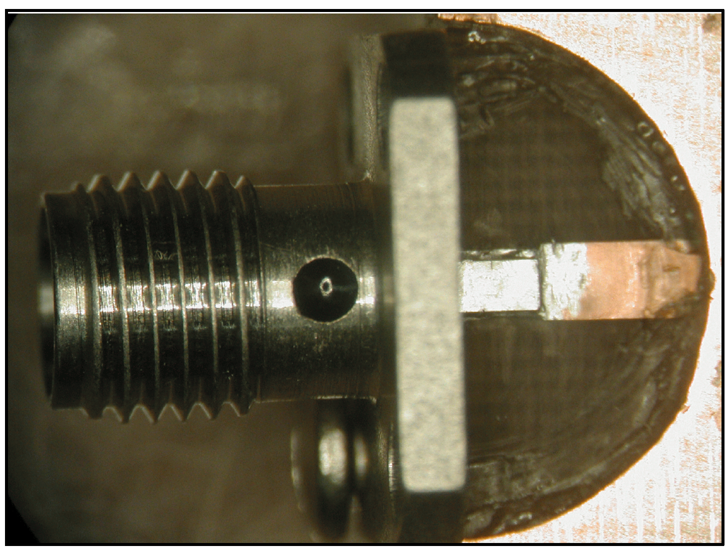

Figure 4. The connector is soldered to the trace. Notice that the tab of the connector spans the 66 mil section of trace. One 2-56 screw is used to hold the connector to the support hardware.

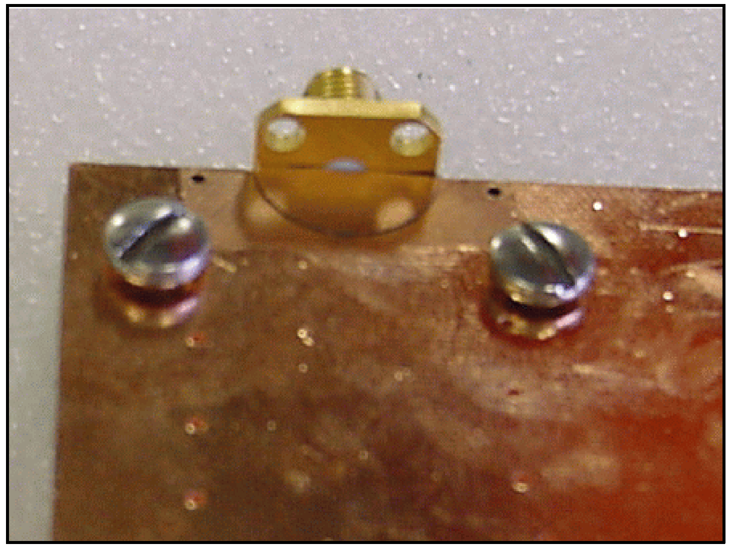

Figure 5. The connector has been soldered to the circuit card, the semicircular cutout has been placed into the semicircular void on the circuit card. This picture also shows the screws used to hold the bottom piece of hardware that hold the connector onto the circuit board.

soldered to the board is shown in Fig. 4. The SMA connector shown in this figure is the M/A-Com 2052-1618-02. A small amount of solder paste is used to connect the tab of the connector to the strip. The tab of the connector is 100 mils in length, and this is the length of the 66 mil section of the disrupted section shown in Figs. 1-2. Excess solder is wiped away using solder wick.

Once the connecter is soldered to the circuit card, the half moon piece must be placed in the void between the connector and the circuit card. Two pictures of this part of the assembly is shown in Figs. 5-6. The screws shown in Fig. 5 are used to hold the bottom piece of hardware to the circuit card.

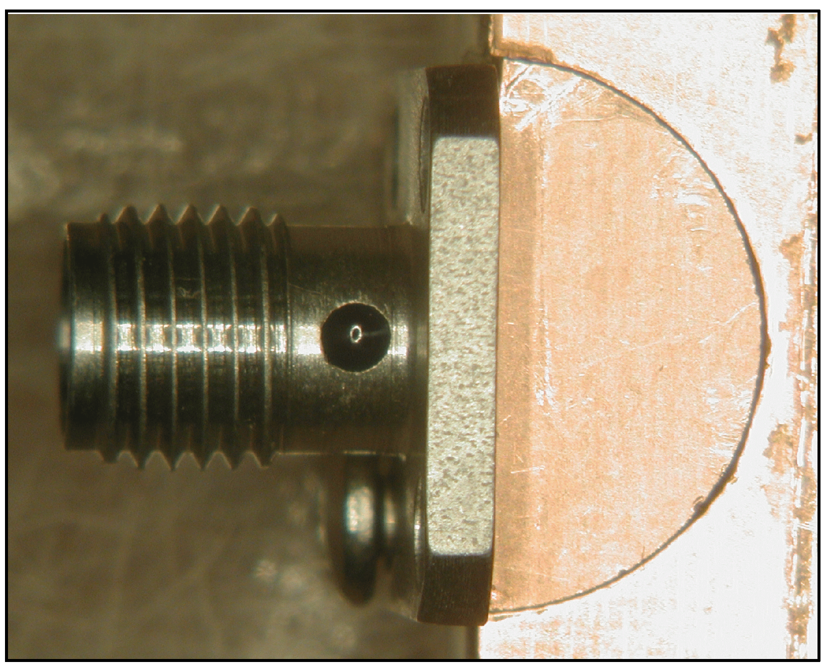

Figure 6. Closeup of the connector with the semicircular cutout in place.

Once the semicircular

cutout is placed in the void, then the final hardware can be put onto the circuit board. A picture of a completed assembly is shown in Figs. 7-8.

III. Evaluation of the Performance of the Launch

The performance of the launch is easily evaluated with either a TDR (time domain reflectometer), or with a VNWA (vector network analyzer) with a time domain option. I found the best performance and least noisy measurement using the VNWA.

For the data presented in this next section, the HP8510 was

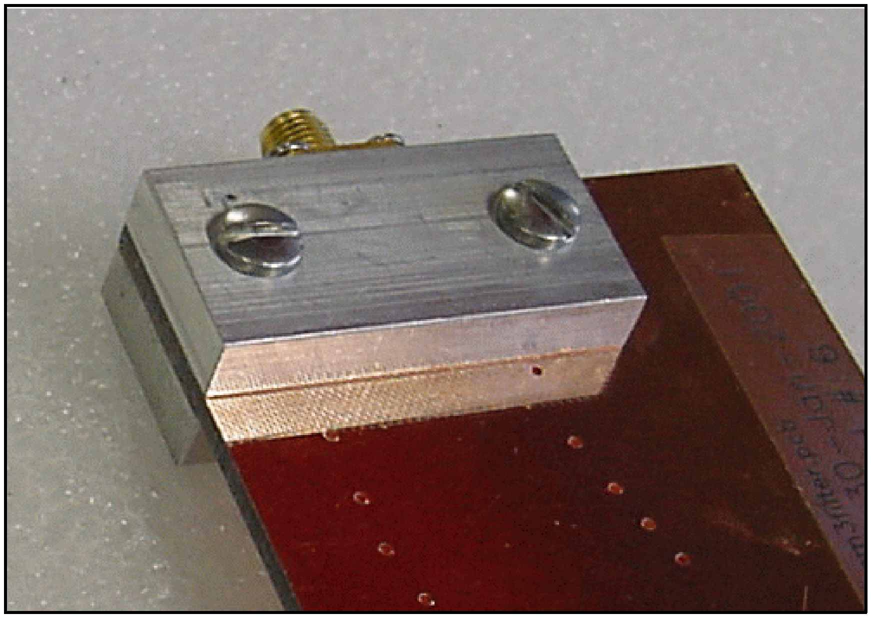

Figure 7. Completed assembly of the connector on the circuit card. The support hardware (FNAL 8035-MB-375835 and FNAL 8035-MB-375836) is shown

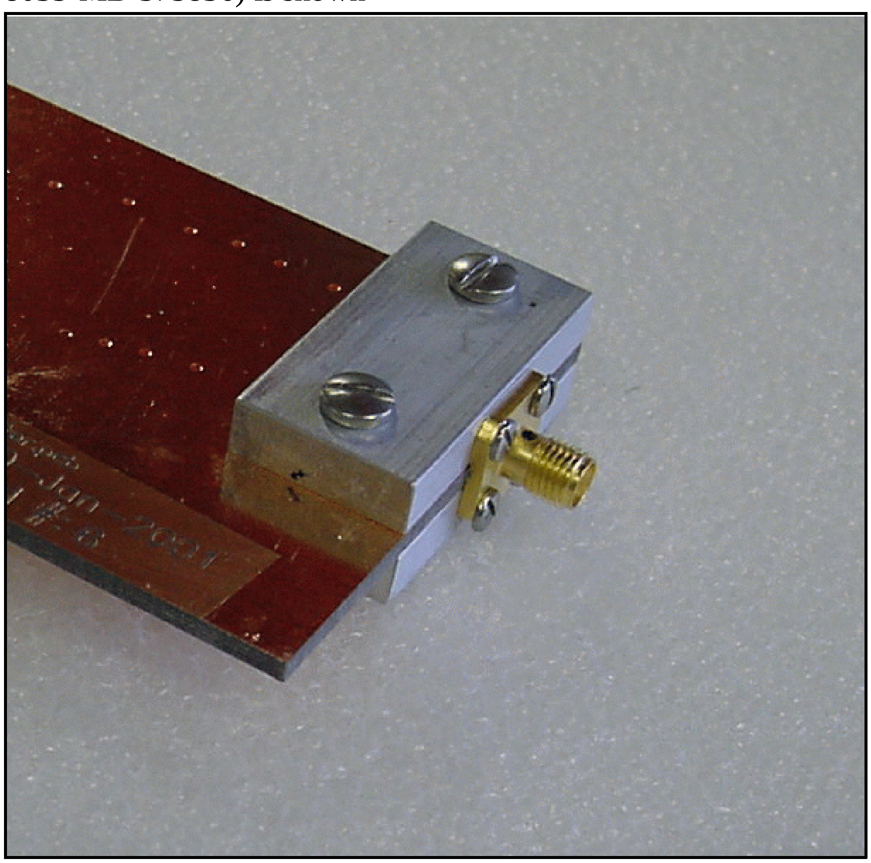

Figure 8. Completed assembly of the connector on the circuit card. Note that all the 2-56 screws are to be used.

used. The starting frequency is 50 MHz, the stopping frequency is 20.05 GHz, uses 401 data points, time step mode, and is calibrated with an SMA calibration for reflection only. After being convinced that the calibration is valid and the measurement is repeatable, the network analyzer is placed into the time domain mode, impulse response, low pass. Since the dielectric constant of the circuit card is known, I know about how long of a response/ring that should be observed. This raises a practical concern that the microwave circuit should

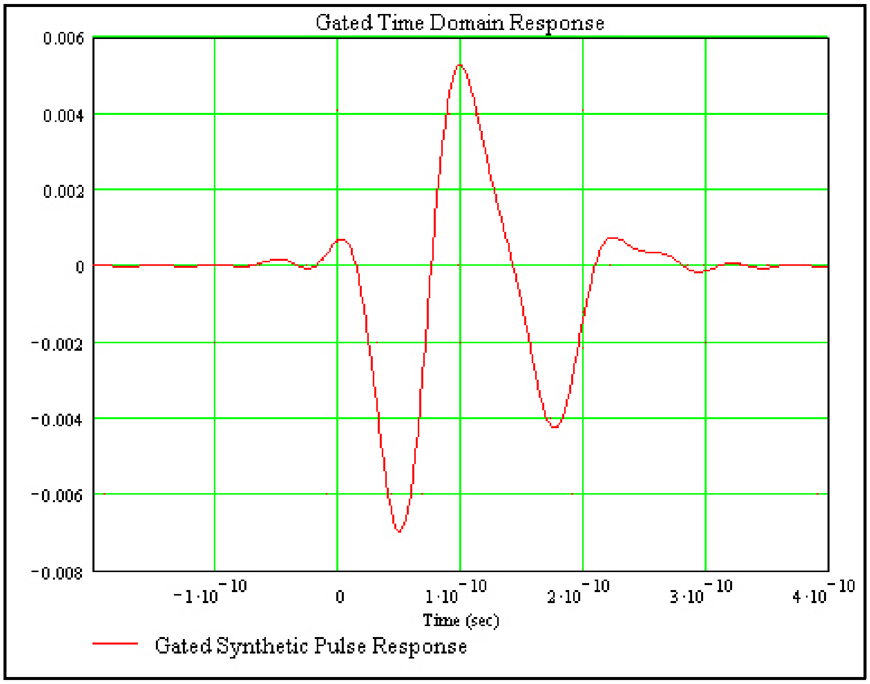

Figure 9. The synthetic pulse measurement, with gating, of a typical connector and launch.

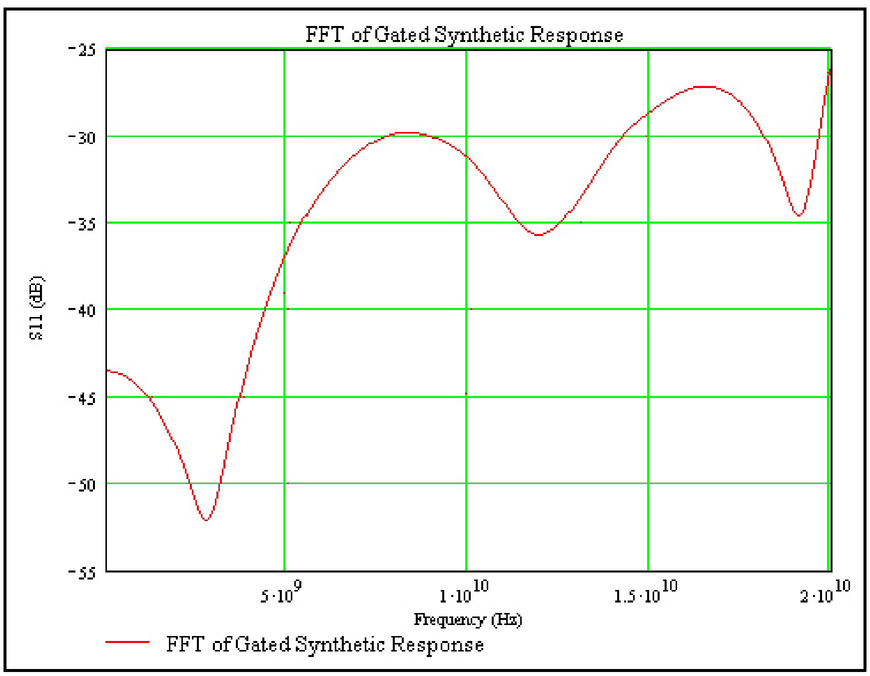

Figure 10. The FFT of the synthetic pulse represented in Fig. 9. This is the reflection caused by the launch into the stripline.

be placed far enough away from the launch so that one can ascertain whether the launch is affecting the microwave circuit. A measurement of the synthetic pulse with an appropriate gate is shown in Fig. 9. This response is a fairly good representation of the quality of launch that is attainable using the methods described in this paper. The frequency domain response of this gated response shows the quality of the launch, and is displayed in Fig. 10.

IV. Conclusion

The launch into stripline can be relatively low reflection if one uses some of the steps and tools described in this paper. The launch can be analyzed on the bench or via FEM codes (which were done for the designs of this paper), and then be built and measured.

Remarks

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